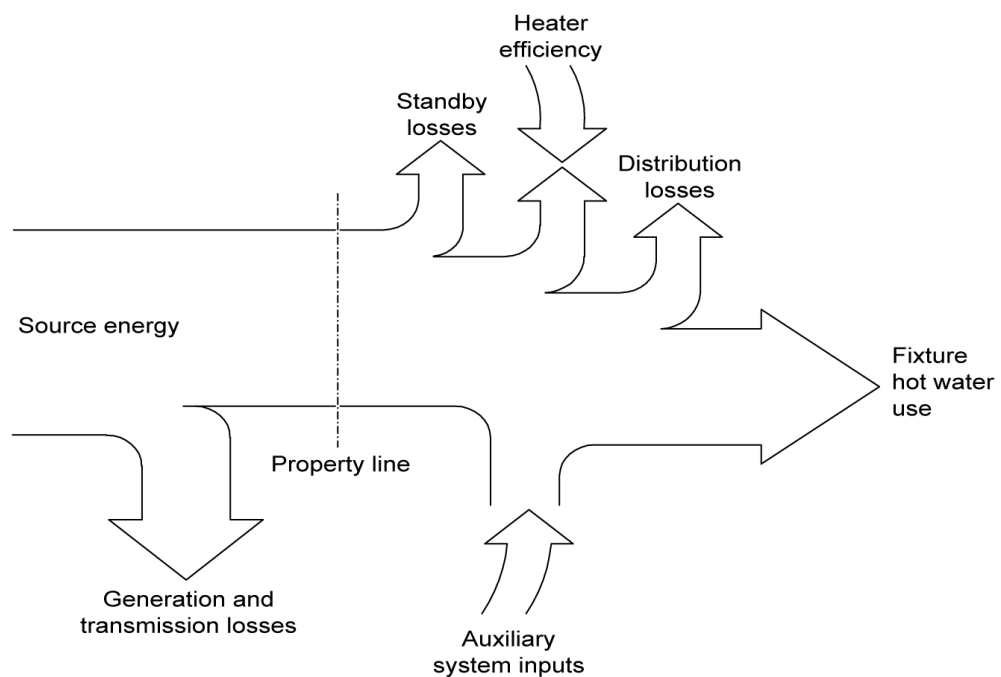

5. Water Heating Requirements

5.1 Overview

5.1.1 Water Heating Energy

Water heating energy use is important in low-rise residential buildings. Standby loss is typically more than a quarter of a gas storage type water heater system's total energy use. However, when the system fuel is natural gas, there are no generation losses as are associated with electricity. Fuel type is very important in determining water heating energy use. While natural gas, LPG or oil can be burned directly to heat water, electricity is typically generated in a power plant. Approximately two thirds of the source energy used to generate electricity is lost in the generation and distribution processes. Any electric water heating system must automatically account for the inefficiency of the fuel type. Standard electric water heaters are not considered energy efficient for this reason. Electric heat pump water heaters, however, are closer to the efficiency of typical gas systems, because they use the outdoor air as a heat source in heating water. The relative values of the losses associated with different sources of energy are integrated into the TDV multiplier.



5.1.2 What's New for 2005

Probably the biggest change is in compliance methods. Due to the change to TDV energy calculations, the water heating budget calculation is no longer practical by hand, and the water heating forms have been eliminated. Therefore, if a system does not meet the prescriptive requirements or an approved alternative system, then an approved performance calculation method is necessary.

The prescriptive requirements have been expanded to allow instantaneous gas water heaters and central gas water heaters that serve multiple dwelling units.

For central systems serving multiple dwelling units, the baseline for performance calculations has been changed so that it also has a central system. The baseline when each unit has its own water heater remains the same, each unit in the baseline will also have its own water heater. The impact of this change will be to increase the stringency of the water heating budget for central systems.

An option is added that allows pipes to be considered insulated if they are located in the attic and buried by ceiling insulation.

In the discussion below, a distinction is made for applicability of various criteria and definitions of systems serving a single dwelling unit versus those serving multiple dwelling units. Some details apply to both. Also, some details applicable to a system serving a single dwelling unit are also applicable to piping within a dwelling unit served by a central water heater or boiler.

5.1.3 Water Heater Types

The following water heater types are recognized by the standards.

- Standard Water Heater - Storage Gas
- Large Storage Gas
- Storage Electric
- Storage Heat Pump
- Instantaneous Gas
- Instantaneous Electric
- Indirect Gas

5.1.4 Distribution System Types

The water heating *distribution system* is the configuration of piping, pumps and controls that deliver hot water from the water heater to fixtures within the building. The standard distribution system for a system serving a single dwelling unit has no recirculation pumps and partial pipe insulation. The standard system includes piping insulation from the water heater to the kitchen fixtures (see Prescriptive Requirements) and the first five ft of piping on the inlet and outlet from the water heater (see Mandatory Requirements).

The standards recognize other distribution systems that may be more or less efficient than the standard system. Table 5-1 gives brief definitions of all of the distribution system types for water heating serving a single dwelling that are recognized by the standards.

Table 5-1 – System Component Descriptions: Distribution Systems within a Dwelling Unit

Distribution Systems	Description
Standard (STD)	Standard system without any pumps for distributing hot water. The first 5 ft of pipes from the storage tank is insulated for both hot and cold water pipes. Pipes from the water heater to the kitchen that are 0.75 in. or larger are insulated. Pipe insulation is required per §150(j).
Point of Use (POU)	System with no more than 8 ft horizontal distance between the water heater and hot water fixtures, except laundry.
Pipe Insulation (PIA)	All hot water pipes are insulated per the requirements of §150(j).
Standard Pipes with No Insulation (SNI)	Standard system, but without insulation on the pipes to the kitchen.
Parallel Piping (PP)	Individual pipes radiate from a manifold on the water heater to each of the fixtures.
Recirculation No Control (RNC)	Distribution system using a pump to recirculate hot water to branch piping through a looped hot water main. Pump operation and water flow are continuous. Pipe insulation is required per §150(j).
Recirculation with Temperature Control (RTmp)	Recirculation system that uses temperature controls to cycle pump operation to maintain recirculated water temperatures within certain limits. Pipe insulation is required per §150(j).
Recirculation with Timer Control (RTm)	Recirculation system that uses a timer control to cycle pump operation based on time of day. Pipe insulation is required per §150(j).
Recirculation with Timer and Temperature Control (RTmTmp)	Recirculation system that uses both temperature and timer controls to regulate pump operation. Pipe insulation is required per §150(j).
Recirculation with Demand Control (RDmd)	Recirculation system that uses brief pump operation to recirculate hot water to fixtures just prior to hot water use when a demand for hot water is indicated. Pipe insulation is required per §150(j).

For water heating systems that serve multiple dwellings, there are separate distribution system definitions and requirements. The terms “Standard,” “Point of Use,” “Standard Pipes with No Insulation” and “Parallel Piping” do not apply to systems serving multiple dwellings. The term “Pipe Insulation” has a different meaning for central water heating systems than for systems serving a single dwelling unit. Piping for recirculation loops is required by the mandatory measures to be insulated, but a higher level of insulation can also save energy and is recognized by the compliance software programs.

Additionally, more information is required for demonstrating compliance of systems serving multiple dwelling units. The compliance documentation must specify the length of piping that is inside the building, outside, or underground, and the insulation R-value on each portion

The base case system used to develop the standard budget for central water heating assumes a minimal amount of piping outside and none underground. It also assumes a recirculation pump with a timer control, and R-4 or R-6 insulation on the pipes (depending upon pipe diameter). The new proposed system also is assumed to have a recirculation pump, but in an existing multiple dwelling building it may lack controls. There is an exception for multifamily

buildings of six units or less using the performance approach when no recirculation pump is installed. However, the distribution system in the Standard Design and Proposed design will both assume a pump with timer controls. See §113(c) 2 and §151(f) 8 C

5.2 Mandatory Requirements

5.2.1 Equipment Certification

§113(a)

Water heaters must be certified by manufacturers as complying with the *Appliance Efficiency Regulations* at the time of manufacture. Regulated equipment may not be sold in California unless it is certified. This includes the following types of water heaters:

- Gas water heaters and boilers
- Heat pump water heaters
- Electric water heaters and boilers
- Oil-fired water heaters and boilers.

5.2.2 Equipment Efficiency

§113(b), §111

Small water heaters are regulated by the federal standards. The efficiency requirements for such equipment are given in Table 5-2 below. The efficiency rating for small water heaters is called the energy factor (EF). The EF is intended to represent the overall efficiency of a water heater, combining the recovery efficiency and standby losses. The Energy Factor for water heaters other than heat pump water heaters is a number that varies between zero and less than one, and is based on standard test conditions designed to represent a typical 24-hour period. During the test, 64.3 gallons of hot water is withdrawn in six equal draws at one hour intervals and then the water heater sits idle for the remaining 24 hour period. Set point temperatures and inlet temperatures are standardized for the test.

Table 5-2 – Minimum Energy Factor Small Water Heaters

Source: Energy Commission Appliance Efficiency Regulations, Table F-4 – Standards for Small Federally-Regulated Water Heaters

Type	Size	Energy Factor (EF)
Gas Storage	≤ 75,000 Btu/hr	0.67-(0.0019*V)
Gas Instantaneous	≤200,000 Btu/hr	0.62-(0.0019*V)
Oil Storage	≤105,000 Btu/hr	0.59-(0.0019*V)
Oil Instantaneous	≤210,000 Btu/hr	0.59-(0.0019*V)
Electric Storage (exc. Table top)	≤ 12KW	0.97-(0.00132*V)
Electric Table Top	≤ 12KW	0.93-(0.00132*V)
Electric Instantaneous (exc. table top)	≤ 12KW	0.93-(0.00132*V)
Heat pump Water Heater	≤ 24 Amps	0.97-(.00132*V)

Note: V refers to tank volume (gal). Effective Date January 20, 2004


The energy efficiency of equipment that is larger than the sizes indicated in Table 5-2, are regulated by the California Appliance Efficiency Regulations. Energy factor is not used for larger equipment, but rather minimums are specified for thermal efficiency and standby loss as shown in Table F-3 (see Appendix B).

The minimum efficiency of new water heaters is not something that needs to be checked at the building counter when the prescriptive method is used, since this is an appliance standard and applies at the point of sale. Water heater efficiency may be a factor in compliance, however, when the performance method is used.

Energy Factor

Used to measure the efficiency of water heaters, the Energy Factor (EF) is “the ratio of energy output to energy consumption of a water heater, expressed in equivalent units, under designated operating conditions over a 24-hour use cycle, as determined using the applicable test method in the Appliance Efficiency Regulations.” [§101]

<p>HVAC equipment subject to certification includes:</p> <ul style="list-style-type: none"> • Room air conditioners • Central air conditioners with a cooling capacity less than 135,000 Btu/hr • Central air conditioning heat pumps • Fan type central furnaces with input rate less than 400,000 Btu per hour • Boilers • Wall furnaces • Floor furnaces • Room heaters • Unit heaters • Duct furnaces 	<p>The following types of gas space heaters do not need to be certified:</p> <ul style="list-style-type: none"> • Gravity type central furnaces • Heaters installed in mobile homes at the time of construction • Heaters designed expressly for use in recreational vehicles and other mobile equipment • Fan type central furnaces with input rates of at least 400,000 Btu per hour • Infrared heaters
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5.2.3 Pipe Insulation

§150(j)2 Pipe Insulation

Pipe insulation is a mandatory requirement in the following cases:

- Storage tanks for a non-recirculating system must have pipe insulation on both hot and cold water pipes for a length of five ft. There is no exception for water heater piping in the conditioned space.
- Recirculating sections of domestic hot water systems must be insulated (the entire length of piping, whether buried or exposed).
- Indirect fired domestic hot water system piping from the heating source to the storage tank.

Piping *exempt* from the mandatory insulation requirement includes:

- Factory installed piping within space conditioning equipment.
- Piping that penetrates framing members is not required to have insulation where it penetrates the framing. However, if the framing is metal then some insulating material must prevent contact between the pipe and the metal framing.
- Piping located within exterior walls other than for a recirculation loop, does not need to be insulated if all the requirements for Insulation Installation

framing is metal then some insulating material must prevent contact between the pipe and the metal framing.

- Piping located within exterior walls other than for a recirculation loop, does not need to be insulated if all the requirements for Insulation Installation Quality are met (See Appendix ACM RH-2005 in the *Residential ACM Manual*).
- Piping located in the attic does not need pipe insulation if it is buried by at least 4 in. of ceiling insulation.
- Piping that serves process loads, gas piping, cold domestic water piping (other than within five feet of the water heater), condensate drains, roof drains, vents, or waste piping.

Other installation information:

- No insulation should be installed closer than six in. from the flue. If possible, bend the pipe away from the flue. Otherwise, it may be necessary to stop pipe insulation short of the storage tank (see *2001 California Mechanical Code*, Chapter 3, Table 3-3).
- All pipe insulation seams should be sealed.
- Installed piping may not be located in supply or return air plenums.
- Hot and cold water piping, when installed in parallel runs should be a minimum of 6 in. apart.
- If a fire wall interrupts the first 5 ft of pipe, the insulation may be interrupted at the wall and continued on the other side.

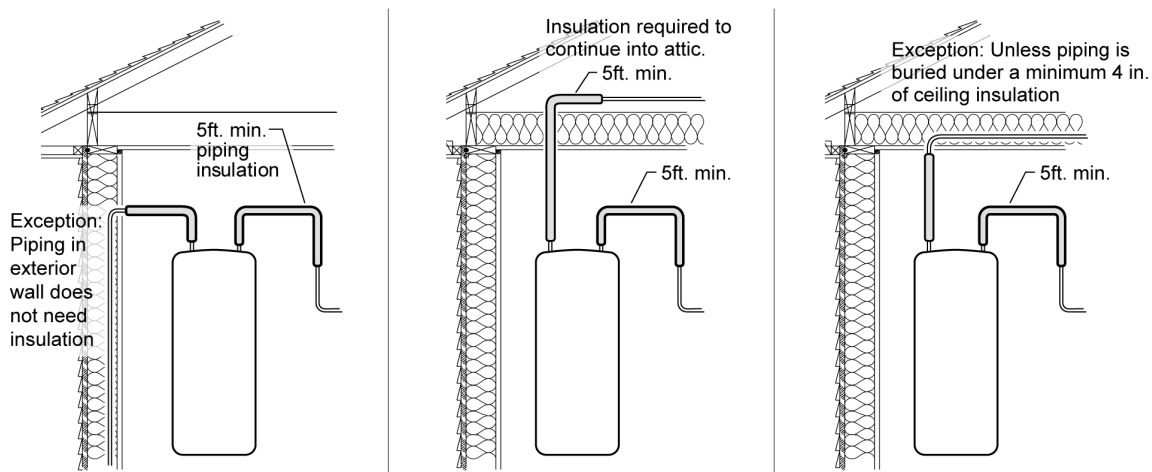


Figure 5-1 – Meeting Pipe Insulation Requirements for Storage Tank Water Heaters

Table 150-B

Where insulation is required as described above, one in. of R-4 insulation is typically required. This requirement applies to domestic hot water pipe (above

105° F) when the pipe diameter is two in. or smaller, the water temperature is between 105°F and 201°F, and the insulation conductivity between 0.24 and 0.28 Btu-in/hr-ft²-°F (typical of cellular foam pipe insulation material). One and one half in. insulation is required on pipes greater than 2 in.

5.2.4 Insulation Protection

§150(j)3.

If hot water piping insulation is exposed to weather, it must be suitable for outdoor service. For typical cellular foam pipe insulation, this means protection with aluminum, sheet metal, painted canvas, plastic cover, or a water retardant paint coating that shields from solar radiation.

5.2.5 Certification of Showerheads and Faucets

§113(a)

Maximum flow rates are set by the Appliance Efficiency standards, and all faucets and showerheads sold in California must meet these standards. The limits for showerheads are 2.5 gallons per minute (gpm) at 80 psi water pressure. The limit for lavatory faucets and kitchen faucets is 2.2 gpm at 60 psi.

5.2.6 Storage Tank Insulation

§150(j)1 Tank Insulation

Exterior tank insulation (R-12 wrap) is a mandatory requirement for storage gas, propane or oil water heaters that have an energy factor of less than 0.58. The minimum efficiency for small water heaters up to 50 gallons is 0.58EF or greater, effectively eliminating the exterior tank insulation requirement. However, for water heater with capacity of 50 gallons or greater, a wrap may be required.

Large storage water heaters with a rated input greater than 75,000 Btu/h that are not rated with an EF are not required to have an external R-12 insulation blanket.

§113(c)4.

Any unfired tanks (used as a back-up for solar water heating or as storage for a boiler) must either be insulated externally with R-12 or have a label indicating the tank is internally insulated with R-16. Alternatively, a tank can comply with this mandatory measure if calculations are provided that show that the average heat loss is less than 6.5 Btu/hr-ft² when there is a temperature difference of 80°F between the water in the tank and the ambient air.

5.2.7 Solar or Recovered Energy in State Buildings

§113(c)5.

Low-rise residential buildings constructed by the State of California shall have solar water heating systems. The solar system shall be sized and designed to

provide at least 60% of the energy needed for service water heating from site solar energy or recovered energy. There is an exception when buildings for which the state architect determines that service water heating is economically or physical infeasible. See the Compliance Options section below for more information about solar water heating systems.

5.2.8 Pool and Spa Equipment

§115

Pool and spa heaters may not have continuously burning pilot lights.

§114

Before any pool or spa heating system or equipment may be installed, the manufacturer must certify to the Energy Commission that the system or equipment complies with §114. The requirements include minimum heating efficiency, an on-off switch, permanent operating instructions, no pilot light, and no electric resistance heating. There are two exceptions for electric heaters, which may be installed for:

- Listed package units with fully insulated enclosures (e.g., hot tubs), and with tight-fitting covers, insulated to at least R-6.
- Pools or spas getting 60% or more of their annual heating from site solar energy or recovered energy.

Any heated pool or spa must be installed with all of the following:

- At least 36 in. of pipe between the filter and heater to allow for the future addition of solar heating equipment.
- A cover for outdoor pools or outdoor spas except for pools or spas deriving at least 60% of the annual heating energy from site solar energy or recovered energy.

If the heating system or equipment is for a pool:

- a. The pool must have directional inlets to adequately mix the pool water.
- b. The circulation pump must be capable of being set to run for the minimum number of hours to maintain the water in an acceptable condition and to run at off-peak electric demand periods.

Example 5-1

Question

Under what circumstances is a constantly (or continuously) burning pilot light prohibited on certain appliances?

Answer

For compliance with the building standards, §115 prohibits continuously burning pilot lights for some natural gas burning equipment (this does not include liquefied petroleum gas burning appliances). §115 prohibits continuous pilots on the following types of equipment:

- Household cooking appliances with an electrical supply voltage connection in which each pilot consumes 150 Btu/hr or more

- Pool heaters
- Spa heaters
- Fan type central furnaces

§150 (e) prohibits continuously burning pilot lights for:

- Fireplaces
- Decorative gas appliances
- Gas logs

For compliance with federal and state appliance regulations (which apply to any appliance sold or offered for sale in California), a constant burning pilot light is prohibited on:

- Gas kitchen ranges and ovens with an electric supply cord
- Pool heaters, except those that burn liquefied petroleum gas

Example 5-2

Question

I thought I was supposed to insulate the water heater pipes for either the first 5 ft or the length of piping before coming to a wall, whichever is less. Did I misunderstand?

Answer

Yes. The requirement is that you must insulate the entire length of the first 5 ft, regardless of whether there is a wall (standards, §150(j)2). You have two options: (1) interrupt insulation for a fire wall and continue it on the other side of the wall, or (2) run the pipe through an insulated wall, making sure that the wall insulation completely surrounds the pipe.

Example 5-3

Question

When insulating the water heater piping, do I need to put insulation on the first 5 ft of cold water pipe?

Answer

Yes. §150(j)2 requires insulation on the cold water pipe also. When heated, the water expands and pushes hot water out the cold water line. This can start thermosyphoning, which continues to remove heat from the stored water. The insulation helps reduce this effect.

Example 5-4

Question

When I'm insulating the pipes for a recirculating water-heating system, I insulate the entire length of hot water pipes that are part of the recirculation loop. Do I also need to insulate the runouts?

Answer

No. Since the water in runouts does not recirculate, they do not need to be insulated. However, the standard budget in a performance calculation will assume the pipes larger than $\frac{3}{4}$ in. diameter are insulated all the way to the kitchen faucet, so your project may suffer an energy penalty for not insulating them.

5.3 Prescriptive Requirements

5.3.1 Pipe Insulation on Lines to Kitchen

§ 151 (f)8

It is a prescriptive requirement that all hot water pipes of $\frac{3}{4}$ in. or larger that run from the heating source to the kitchen fixtures must be insulated. The amount of insulation required is described above under mandatory requirements, typically one inch. Since this is a prescriptive requirement, it may be possible to comply without insulation if the water heating system as a whole meets the performance standard described in §151(b)1 or if the building as a whole complies under the performance method.

5.3.2 Systems Serving Individual Dwelling Units

Package D

§ 151(b)1 and 151(f)8

To meet the prescriptive requirements of Package D, systems serving individual dwelling units shall have a single gas, propane or oil storage type water heater with a tank capacity less than or equal to 50 gallons and a standard distribution system (no recirculating pumps). A single gas, propane or oil instantaneous water heater is also acceptable. Exterior tank insulation is only required for storage gas water heaters with an EF lower than 0.58.

The other option under the prescriptive compliance method is to meet the TDV energy budget for water heating as described in §151(b)1 of the standards. This option may be used to show equivalency to the prescriptive requirements for all other water heating systems. This path requires a rather detailed calculation that is only practical using computer compliance programs. However, Table 5-3 shows a few alternative water heater systems that have been precalculated to comply when serving a single dwelling unit. These are only a few of many possible combinations that will comply.

Table 5-4 – Preapproved Alternative Water Heating Systems for Single Dwelling Units (Equivalent to prescriptive requirement)

System type	System Approved
Multiple (more than one) Instantaneous gas or propane with no pilot light and an energy factor of 0.85 or greater	YES
Heat pump water heater of 50 gallons or less with an energy factor of 2.5 or greater with a solar system contributing at least 25% of the total water heating requirements	YES
Two 50 gallon or less storage gas or propane fired units each with energy factor of 0.67 or greater and pipe insulation	YES
Storage gas of 50 gallons or less with an energy factor of 0.59 or greater with Parallel Piping	YES
Storage Gas of 50 gallons or less with an energy factor of 0.62 or greater with Demand Recirculation	YES
Storage Gas of 50 gallons or less with an energy factor of 0.58 or greater with time and temperature recirculation control and a solar system contributing at least 25% of the total water heating energy use	YES
50 Gal Electric with an energy factor of 0.94 or greater, pipe insulation and solar with at least a 60% solar fraction.	YES (only in areas where natural gas is not available)
Water Heater heat pump of 50 gallons or less with an energy factor of 2.5 or greater and pipe insulation	YES (only in areas where natural gas is not available)

Package C

If Package C is used for overall compliance, an electric water heater is permitted only if it meets the following requirements:

- Storage tank capacity is 50-gallon or less;
- Standard or point of use distribution system (non-recirculating);
- Water heater is located within the building envelope; and
- A solar system or a wood stove boiler provides at least 25% of the water heating requirements. The wood stove boiler credit is not allowed in Climate Zones 8, 10 or 15, or in other jurisdictions that do not allow wood stoves.

Example 5-5

Question

How do the standards apply to a single family residence with one non-recirculating 40-gallon gas water heater?

Answer

This qualifies as a standard water heating system and complies automatically. No water heating calculations are required, although they may be performed to take credit for a particularly efficient water heater.

Example 5-6**Question**

A 1,800 ft² single family residence has two identical 30-gallon gas storage tank water heaters and a point of use distribution system. Does this comply?

Answer

Because there are two water heaters, this system does not meet the standard prescriptive water heating systems requirements of §151(f)8, the system must be shown to meet the water heating budget of §151(b)1. The precalculated values in Table 5-4 above shows that this system with pipe insulation and an energy factor of 0.67 meets the energy budget. If compliance credit is desired, then the performance compliance method may be used.

Example 5-7**Question**

A 6,000-ft² single family residence has 3 storage gas water heaters (40 gallon, 30 gallon and a 100-gallon unit with 80,000 Btuh input). Does it comply?

Answer

The system does not meet the standard requirements and must be shown to meet the water heating budget of §151(b)1. Therefore a performance calculation is required, either for the water heating system on its own or as part of the whole building approach.

Example 5-8**Question**

A single family residence has one non-recirculating 50-gallon gas water heater. The water heater has an input rating of 76,000 Btu/hr. Does it comply?

Answer

Even though this water heater has an input rating greater than 75,000 Btu/hr, it still qualifies as a standard water heater because it is a storage gas heater of 50 gallons or less. The system still qualifies as a standard water heating system because it meets all of the stated requirements. No water heating calculations are required, and the system complies automatically.

5.3.3 Systems Serving Multiple Dwelling Units

To meet the prescriptive requirements, water heaters that serve multiple dwelling units must be gas, oil or propane central recirculating system. Any number of water heaters may be used and any size may be used as long as they are equipped with timer controls and meet the mandatory measure minimum efficiency requirements of §111 or §113.

Recirculating systems may be used as long as they have controls to turn off the pumps when hot water is not needed (e.g., timer controls). Pipes must be insulated as described earlier under mandatory requirements.

Any system not meeting these prescriptive requirements must instead meet the water heating performance budget as described in §151(b)1, or must follow the performance compliance method for the building as a whole. In this case, it is

important to note a change in the ACM calculations for 2005. Previously, the performance baseline was an individual water heater for each unit in a multifamily building, regardless of the proposed system configuration. In the 2005 standards, the baseline is a central water heating system whenever the proposed system serves multiple dwelling units. The result of this change is that the water heating budget will turn out to be more stringent than in the past for systems serving multiple dwellings.

Example 5-9

Question

A 10-unit multifamily building has separate gas water heaters for each dwelling unit. Five units have 30-gallon water heaters, and five units have 50-gallon water heaters. Does this comply?

Answer

Water heating calculations are not required if each system is non-recirculating and each water heater has a 0.58 or higher EF, because each dwelling unit has a standard water heating system.

Example 5-10

Question

We are building an 8-unit, 7,800 ft² multifamily building with a 200 gallon storage gas water heater with a time and temperature controlled recirculation system that has R-4 insulation on all the piping. The system serves all the units. Do I have to perform calculations to show compliance?

Answer

Water heating calculations are not needed because this system meets all the requirements of Section 151(f)8.

Example 5-11

Question

We are building a 10-unit apartment building with a single large water heater. We do not plan to install a recirculation pump and loop. Does this meet the Prescriptive requirements?

Answer

No. Since it is unlikely that a non-recirculating system will satisfactorily supply hot water to meet the tenants' needs, a recirculating system must be installed to meet the Prescriptive requirements. There is an exception for multifamily buildings of six units or less using the performance approach. For central hot water systems serving six or fewer dwelling units which have (1) less than 25' of distribution piping outdoors; (2) zero distribution piping underground; (3) no recirculation pump; and (4) insulation on distribution piping that meets the requirements of Section 150 (j) of Title 24, Part 6, the distribution system in the Standard Design and Proposed design will both assume a pump with timer controls.

5.4 Compliance Options

5.4.1 Performance Compliance

The computer performance approach can be used to demonstrate compliance for system efficiency, fuel type, system type, distribution system, and auxiliary systems that do not necessarily meet the prescriptive requirements.

5.4.2 Auxiliary Systems

The Water Heating Calculation Method allows water heating credits for solar water heaters and wood stove boilers because these systems save energy by using nondepletable resources as energy sources.

Solar Water Heaters

As noted earlier, solar water heating is a mandatory requirement for State buildings. A solar system (or wood stove boiler) is also required to meet the prescriptive requirements of Package C when an electric resistance water heater is installed. For all other buildings, a water heating credit is available when following the performance compliance path. Credit is available for both passive and active solar water heating systems.

For solar water heating systems, an approved method must be used to determine the Solar Savings Multiplier. Two calculation approaches may be used. To determine the solar contribution of a solar water heating system that has been rated using the SRCC OG 300 procedure, use either form CF-SR which is located in Appendix A, or go to the Commission website at www.energy.ca.gov and download a spreadsheet form. For solar systems that are built up for single or multifamily buildings, a California version of F-chart is available at www.energy.ca.gov in the building standards area of the website.

Mandatory requirements for pipe insulation and storage tank insulation apply as described earlier in this chapter.

Wood Stove Boilers

Wood stoves equipped with heat exchangers for heating domestic hot water can receive credit through the water heating performance calculation method. The savings range from zero (no credit) up to 30% depending on the climate zone and whether or not the system uses a circulation pump.

To receive the compliance credit, the following criteria must be met:

- The building department having jurisdiction has determined that natural gas is not available.
- A tempering valve must be installed at the outlet of the water heater to prevent scalding.
- A pressure-temperature relief valve must be installed at the wood stove.

- The wood stove boiler must be properly sized to minimize the amount of excess hot water produced by the unit.
- All health and safety codes, including codes applying to pressurized boiler vessels, must be met.
- To calculate credits for wood boilers, use the performance method.

5.4.3 Combined Hydronic

Combined hydronic space heating systems serve two functions, providing both space heating and domestic hot water. The system is analyzed for its water heating performance as if the space heating function were separate. Chapter 4 provides an explanation of combined hydronic systems.

5.4.4 Distribution System Options

There are two distribution system alternatives (Point of Use and Pipe Insulation, (see Section 4.6.2, Distribution Systems) that are more efficient than the standard system, and credit is available through the performance compliance approach.

For systems serving individual dwelling units, the standard distribution meets mandatory pipe insulation requirements and also has pipe insulation on the line to the kitchen greater than or equal to ¾ in. diameter when using prescriptive compliance. Credit is available for insulating all hot water piping or for a point of use distribution system.

For systems serving multiple dwelling units with a recirculating pump, extra credit is available for additional insulation, as well as for having all the piping inside the building envelope. The standard system is assumed to have R-4 insulation on piping up to 2 in., R-6 insulation on piping over 2 in. in diameter, no piping underground, and only 5% of the piping outside.

Example 5-12

Question

Can I get pipe insulation credit for a recirculating water-heating system?

Answer

Not for systems serving a single dwelling unit. Recirculating water heating systems have a mandatory insulation requirement for the recirculating section of the hot water pipes. Pipes less than 2 in. must be insulated to R-4 and pipes greater than 2 in. need R-6 insulation. For systems serving multiple dwelling units, using R-6 where R-4 is required, and R-8 where R-6 is required, results in credit within the performance approach. All the circulation loop pipes in one location type (e.g., inside, outside, underground) must be insulated to the higher level to qualify.

5.5 Compliance and Enforcement

Chapter 2 addresses the compliance and enforcement process in a general manner and discusses the roles and responsibilities of each of the major parties, the compliance forms, and the process for field verification and/or diagnostic testing. This section highlights some of the compliance and enforcement issues for the water heating system.

5.5.1 Design

The initial compliance documentation consists of the Certificate of Compliance (CF-1R) and the mandatory measures checklist (MF-1R). These documents are included on the plans and specifications. The CF-1R has a section where special features are listed. The following are water heating features that should be listed in this section if they exist in the proposed design:

- Any system type other than one water heater per dwelling unit
- Non NAECA large water heater performance
- Indirect water heater performance
- Instantaneous gas performance
- Distribution systems
- Solar system
- Wood stove boiler
- Combined hydronic system
- Any multifamily building with a central water heating and distribution system where some dwelling units are served by an individual water heater.

5.5.2 Construction

During the construction process, the contractor and/or the specialty contractors complete the necessary sections of the Installation Certificate (CF-6R). For water heating there is only one section to be completed where information about the installed water heating system is entered.

Inspectors should check that the number and types of water heater systems installed, as indicated on the CF-6R, corresponds to the approved CF-1R. The distribution system is also significant and must correspond to plan specifications. For example:

- If a recirculation system is installed, verify that it was accounted for in the compliance documentation (CF-1R) and check for any required controls (e.g., demand pump, timer).
- If the water heating systems serves more than one dwelling unit, verify the total length of the distribution loop, the

approximate length of the loop in each of the three location types (inside, outside, underground), and the amount of insulation on the piping in each.

- If a point of use credit is specified, the water heater must be no further than 8 ft from all hot water outlets (excluding washing machines).
- Verify that the make and model number of the installed water heater unit matches that listed on the Installation Certificate (CF-6R).
- Verify installation of a timer control or a time and temperature control on a multifamily building with central water heating and recirculating system.

For most central water heating distribution systems in multifamily buildings, any distribution systems for supplying hot water from a central boiler or water heater should be assumed to have a recirculation pump and assume that one would be supplied retroactively if not initially.

For central hot water systems serving six or fewer dwelling units that have:

- less than 25 ft of distribution piping outdoors;
- zero distribution piping underground;
- no recirculation pump; and
- insulation on distribution piping that meets the requirements of §150 (j) of the standards, a pump and timer are not required to be installed. When calculating the energy use of these multifamily distribution systems, the distribution system in the Standard Design and Proposed design will both be assumed to have a pump with timer controls even when one is not installed.

5.5.3 Field Verification and/or Diagnostic Testing

The only element of a water heating system that requires field verification is where insulation credit is taken for hot water pipes located in the attic and buried by ceiling insulation. In this case, a HERS rater must verify that the Insulation Installation Quality requirements are met and indicate compliance on the Certificate of Field Verification and Diagnostic Testing (CF-4R)
Glossary/Reference

5.6 Glossary/Reference

Relevant terms are defined in Joint Appendix I.

The following are terms that are either not defined in Joint Appendix I or expansions to the Appendix I definitions.

Recovery Energy

Recovery energy is the energy used to heat water, including the inefficiency (or efficiency loss) of the heater.

Recovery Load

Recovery load is the amount of energy in hot water that the water heater needs to provide. It includes only the energy in the hot water that is used by the building occupant and the distribution losses.

Thermal Efficiency

Thermal efficiency is defined in the Appliance Standards as a measure of the percentage of heat from the combustion of gas or oil that is transferred to the hot water as determined using the applicable test methods.

5.6.1 Water Heater Types***Storage Gas***

A gas water heater designed to heat and store water at less than 180°F. Water temperature is controlled with a thermostat. Storage gas water heaters have a manufacturer's specified storage capacity of at least two gallons and less than or equal to 75,000 Btu/h input.

Large Storage Gas

A storage gas water heater with greater than 75,000 Btuh input.

Storage Electric

An electric water heater designed to heat and store water at less than 180°F. Water temperature is controlled with a thermostat. Storage electric water heaters have a manufacturer's specified storage capacity of at least two gallons.

Storage Heat Pump

An electric water heater that uses a compressor to transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water. It includes all necessary auxiliary equipment such as fans, storage tanks, pumps or controls. EFs for heat pump water heaters are found in the Energy Commission's Appliance Database under Certified Water Heaters.

Instantaneous Gas

A gas water heater controlled manually or automatically by a water flow activated control or a combination of water flow and thermostatic controls, with a manufacturer's specified storage capacity of less than two gallons.

pumps or controls. EFs for heat pump water heaters are found in the Energy Commission's Appliance Database under Certified Water Heaters.

Instantaneous Gas

A gas water heater controlled manually or automatically by a water flow activated control or a combination of water flow and thermostatic controls, with a manufacturer's specified storage capacity of less than two gallons.

Instantaneous Electric

An electric water heater controlled automatically by a thermostat, with a manufacturer's specified storage capacity of less than two gallons.

Note: Instantaneous water heaters are not generally designed for use with solar water heating systems or as heat sources for indirect fired water heaters. They are also typically inappropriate for use with recirculation systems. Consult manufacturer's literature when considering these applications.

Indirect Gas

A water heater consisting of a storage tank with no heating elements or combustion devices, connected via piping and recirculating pump to a heat source consisting of a gas or oil fired boiler, or instantaneous gas water heater (see note following the definitions of Instantaneous Gas and Electric).

As described above in the section on Mandatory Requirements, the storage tank must be insulated in accordance with §150(j)1B of the standards, which requires a factory-installed minimum of R-16 (labeled on outside of tank) or a minimum of R-12 external insulation.

The piping connecting the heating source and the storage tank must also meet the mandatory requirements, typically one in. of R-4 insulation. This includes any piping located in concrete slabs or underground.

5.6.2 Distribution Systems

The water heating distribution system is the configuration of piping, pumps and controls that regulates delivery of hot water from the water heater to all end uses within the building. The water heating calculation method gives credits for energy-efficient distribution systems, while taking penalties for less energy-efficient systems.

All criteria listed below are based on *Residential Water Heating Study*: March 31, 1991, Energy Commission contract #400-88-003.

Standard Distribution System

Systems Serving Single Dwelling Units

A standard distribution system serving a single dwelling unit that does not incorporate a pump for recirculation of hot water, and does not take credit for

any design features eligible for energy credits. As per the prescriptive requirements, all pipes running to the kitchen that are $\frac{3}{4}$ in. or larger must be insulated.

Installation Criteria:

No pumps may be used to recirculate hot water. The first 5 ft of hot and cold water piping adjacent to the water heater must be insulated according to mandatory requirements.

Systems Serving Multiple Dwelling Units

The standard distribution system for water heaters serving multiple dwelling units incorporates a recirculation pump, controls to shut the pump off when it is not needed, and insulation on all portions of the recirculation loop. As required by the prescriptive approach, the piping to the kitchen must also be insulated.

Standard Pipes with No Insulation

This case is the same as the standard distribution system above, except that the lines of $\frac{3}{4}$ in. or larger to the kitchen are not insulated.

Point of Use

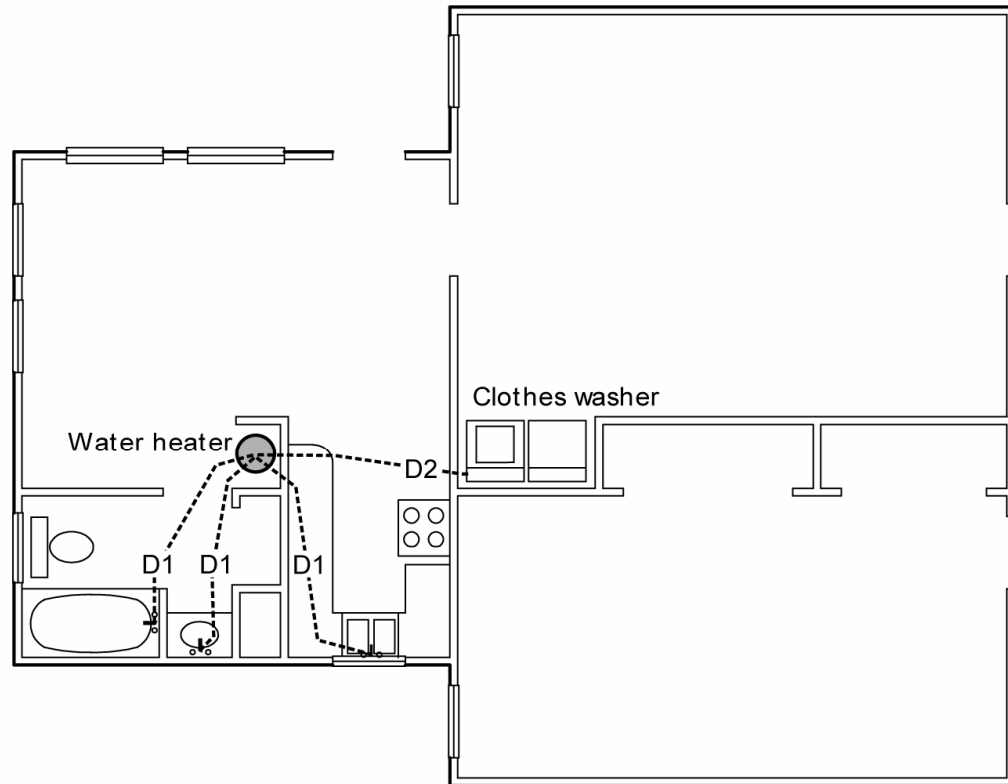
A distribution piping system that limits hot water distribution system heat loss by minimizing the distance between the water heater and fixtures using hot water. This credit is not applicable to systems serving multiple dwelling units.

Installation Criteria:

The distance between the water heater and any fixture using hot water cannot exceed 8 ft, measured in plan view (see Figure 5-2).

All water heaters and hot water fixtures must be shown on plans submitted for local building department plan check.

EXCEPTION: Washing machines for clothing may be located more than eight ft from the water heater.



D1 (distance between water heater and hot water fixture) $\leq 8'-0"$ D2 (distance between water heater and clothes washer) $\geq 8'-0"$

Figure 5-2 – Point of Use Distribution System

Pipe Insulation

Credit is available for insulation of hot water pipes in addition to insulation required by the mandatory requirements. For systems serving a single dwelling unit, this credit applies only to non-circulating systems. For systems serving multiple dwelling units, there is a pipe insulation credit for recirculating piping external to dwelling units if pipes are insulated to a higher R-value than the mandatory minimum.

Installation Criteria (Single Dwelling Unit):

Insulation must meet the level required in the mandatory requirements. Note that pipes buried under ceiling insulation can meet the mandatory requirements.

Note: Heat tape – electric resistance heating tape wrapped around hot water pipes – may be used only for freeze protection and cannot be used instead of mandatory pipe insulation (see Section §150(j)) or pipe insulation receiving distribution credit.

Installation Criteria (Multiple Dwelling Units):

All piping in the same location type (inside, outside, or underground) must be insulated to at least R-6 for pipes up to 2 in. in diameter, or R-8 for pipes larger than 2 in. in diameter.

Pipe insulation for piping located underground or in a slab must be protected by a material that is resistant to compression and crushing so that the insulation value is maintained after installation of covering materials.

Parallel Piping

A parallel piping system limits the amount of heat loss and water lost from the distribution piping by minimizing the volume of hot water left in the pipes at the end of each water draw.

Credit for Parallel Piping can only be used if each hot water use location (each kitchen, each bathroom and each laundry area) has a separate distribution line with a maximum size of half-inch pipe run from the location of the water heater to each hot water use location. This credit does not apply to systems serving multiple dwelling units.

Installation Criteria:

Adequate distribution piping must be supplied to meet the demand at each hot water use location as required by the plumbing code. No piping over one-half in. may be used with the exception of a manifold located within eight ft of the water heater to which the half-inch piping runs are connected. See ACM RG-2005 for detailed criteria.

All water heaters, distribution line runs and fixture points must be shown on the plans.

Recirculation System – No Control

A continuous distribution system using a pump to recirculate hot water to branch piping through a looped hot water main with no control of the pump, such that the pumping is continuous.

Installation Criteria:

All piping used to recirculate hot water must be insulated to meet the mandatory requirements. This includes any recirculating piping located in concrete slabs or underground. Since the standards require this insulation, it is not eligible for the Pipe Insulation credit. For systems serving a single dwelling unit, the recirculating loop within a dwelling unit must be laid out to be within 8 ft of all hot water fixtures served by the recirculating loop.

Recirculation System – Temperature Control

Recirculation system that uses temperature controls to cycle pump operation to maintain circulated water temperatures within certain limits.

Installation Criteria:

All criteria listed for continuous recirculation systems apply.

An automatic thermostatic control must be installed to cycle the pump on and off in response to the temperature of water returning to the water heater through the recirculation piping. Minimum differential or "deadband" of the control shall not be less than 20°F. An alternate temperature control system adjusts the boiler controls so that the temperature of the hot water that is circulated during times of low draw is at least 20° lower than the standard set point. In this case, the pump may run continuously.

Plans must indicate pump and temperature control.

Recirculation System – Timer Control

A recirculation system that uses a timer control to cycle pump operation based on time of day.

Installation Criteria:

All criteria listed for continuous recirculation systems apply.

A timer must be permanently installed to regulate pump operation. Timer setting must permit the pump to be cycled off for at least eight hours per day.

Plans must indicate pump and timer control.

Recirculation System –Timer and Temperature Control

A recirculation system that uses both temperature and timer controls to regulate pump operation, so that the pump is off when the water temperature is high enough even when the timer would have the pump on.

Installation Criteria:

All criteria listed for continuous, temperature controlled, and timer controlled recirculation systems apply.

Recirculation System – Demand Control

Recirculation system that uses brief pump operation to recirculate hot water to fixtures on demand.

Installation Criteria:

All criteria listed for continuous recirculation systems apply.

Pump start-up must be provided by a push button, occupancy sensor or flow switch.

Pump shut-off must be provided by either a temperature sensing device that shuts off the pump when hot water reaches the location of use, or by a timer which limits pump run time to two minutes or less.

For a system serving a single dwelling, at a minimum, push buttons and sensors must be located in the kitchen and master bathroom.

Plans must include a wiring/circuit diagram for the pump and timer/temperature sensing device.

Recirculation systems are not used with instantaneous water heaters.

